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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/750,200	12/30/2003	Swaminathan Sivakumar	42P17540	9156

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EXAMINER	
CHEN, ERIC BRICE	
ART UNIT	**PAPER NUMBER**
1765	

DATE MAILED: 01/27/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/750,200	SIVAKUMAR ET AL.	
	Examiner	Art Unit	
	Eric B. Chen	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-13 and 15* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13 and 15* is/are rejected.

7)☒ Claim(s) *15* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *12/5/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

1. Claim 15 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim, or amend the claim to place the claim in proper dependent form, or rewrite the claim in independent form. Specifically, claim 14 is dependent upon claim 13, which is dependent upon claim 6. Claim 6 recites "an angle approximately 40 degrees to approximately 50 degrees." Any sloping is expected to "facilitate step coverage of a subsequent metallization" and thus, this characteristic does not narrow the scope of the claim. *See* Wolf, *Silicon Processing for the VLSI Era*, Vol. 2, Lattice Press (1992), page 104 ("it is important to give the contact hole a shape that will result in good step coverage by the metal that is deposited into it...*better step coverage will be obtained if the walls of the contact opening are sloped* and the top corners are rounded...") (emphasis added).

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> **The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.**

3. Claim 15 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant

regards as the invention. Specifically, the phrase "sufficient to facilitate" is vague and subject to multiple interpretations.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> **(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.**

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 1-13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takagi et al. (U.S. Patent No. 6,174,796), in view of Wolf, *Silicon Processing for the VLSI Era*, Vol. 2, Lattice Press (1992) ("Wolf II"), as evidenced by Wolf et al., *Silicon Processing for the VLSI Era*, Vol. 1, Lattice Press (1986) ("Wolf I").

7. As to claim 1, Takagi discloses a method of exposing a bond pad comprising: forming the bond pad (105) (column 1, lines 32-34; Figure 1A); forming a dielectric layer

(107) over the bond pad (105) (column 1, lines 32-34; Figure 1A); and exposing the bond pad (column 1, lines 45-47; Figure 1B). Although Takagi does not expressly disclose forming a resist mask with at least one opening to expose the dielectric layer (107) over the bond pad (105), this step is inherently present because the dielectric layer (107) is patterned by photolithography (column 1, lines 35-37). *See* Wolf I, pages 407-408.

8. Takagi does not expressly disclose the remaining elements as claimed by the Applicants. However, Takagi teaches forming at least one opening in the dielectric layer, having a sloped sidewall profile (column 2, lines 45-50) in order to avoid the generation of voids in the metal when the opening is filled, thus minimizing resistance (column 3, lines 5-10; Figure 1D). Moreover, Wolf II teaches a general approach to achieving a sloped sidewall, including heating the resist mask with the at least one opening ("the resist images are subjected to a postdevelop bake...resist flows during the bake, relaxing the vertical resist profile," page 105; Figure 13-4A, page 106); and etching the resist mask and exposed dielectric layer to form at least one opening in the dielectric layer, having a sloped sidewall profile ("[e]tching the resist and oxide at approximately the same rate replicates the tapered-resist profile into the contact sidewall," page 105). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the resist mask with the at least one opening to form a sloped sidewall profile; and etching the resist mask and exposed dielectric layer to form at least one opening in the dielectric layer, having a sloped sidewall profile. One who is skilled in the art would be motivated to minimize the

generation of voids in the metal when the opening is filled, by forming a sloped sidewall and using a common method, such as heating the resist and etching, known to achieve the sloped profile.

9. Takagi does not expressly disclose forming a sloped sidewall profile having an angle of approximately 30 degrees to approximately 60 degrees relative to the surface of the bond pad. However, Wolf II teaches that the slope of the sidewall is determined by the quality of the step coverage of the overlying metal ("it is important to give the contact hole a shape that will result in good step coverage by the metal that is deposited into it...better step coverage will be obtained if the walls of the contact opening are sloped and the top corners are rounded...," page 104) and that the slope of the photoresist can be controlled by baking ("[t]oo little baking results in vertical profiles, while excessive baking can result in closed contacts," page 105). Moreover, by suggesting that the quality of the metal coverage is controlled resist mask sidewall profile, Wolf II teaches that varying mask sidewall profile appears to reflect a result-effective variable which can be optimized. *See* MPEP § 2144.05 II. Mask sidewall profile can be varied accordingly, depending on the desired quality of the overlying metal coverage. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a sloped sidewall profile having an angle of approximately 30 degrees to approximately 60 degrees relative to the surface of the silicon. One who is skilled in the art would be motivated to optimize through routine experimentation sidewall profile. *See* MPEP § 2144.05 II. Although Wolf II teaches forming the inclined dielectric to the silicon surface (Figure 3-14A, page 106), it would

have been obvious to one of ordinary skill in the art at the time the invention was made to form the inclined dielectric to the bond pad surface (105) of Takagi. One who is skilled in the art would be motivated to from an electrical connection with an underlying conductive material (105).

10. As to claim 2, Takagi does not expressly disclose that the heating of the resist mask with the at least one opening persists for a time period ranging from approximately 15 seconds to approximately 90 seconds. However, Wolf II teaches that the slope of the photoresist can be controlled by baking time ("[t]oo little baking results in vertical profiles, while excessive baking can result in closed contacts," page 105) Moreover, Wolf II teaches, by disclosing that the time of exposure may be varied, that changing the time appears to reflect a result-effective variable which can be optimized. *See* MPEP § 2144.05 II. Time of exposure can be varied accordingly, depending on the desired outcome of the sidewall resist mask profile. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the resist mask with the at least one opening persists for a time period ranging from approximately 15 seconds to approximately 90 seconds. One who is skilled in the art would be motivated to optimize through routine experimentation of exposure times. *See* MPEP § 2144.05 II.

11. As to claim 3, Takagi does not expressly disclose that the heating of the resist mask with the at least one opening is performed at a temperature ranging from approximately 160 degrees Centigrade to approximately 190 degrees Centigrade. However, Wolf II teaches heating the resist mask to a temperature of about 150

degrees Centigrade, causing the resist to flow (page 105). Wolf II's temperature of 150 degrees Centigrade is close enough to Applicants' temperature range, such that similar results would be expected (e.g., the resist would flow). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the resist mask with the at least one opening at a temperature ranging from approximately 160 degrees Centigrade to approximately 190 degrees Centigrade. One who is skilled in the art would be motivated to use a temperature range similar to 150 degrees Centigrade, which is known to result in resist flow.

12. As to claim 4, Wolf II discloses that the sloped sidewall profile of the at least one opening of the resist mask is wider at its upper end relative to its lower end (page 106, Figure 3-14A).

13. As to claim 5, Wolf II discloses that the sloped sidewall profile of the opening in the dielectric layer ("SiO_2") is wider at its upper end relative to its lower end (page 106, Figure 3-14A).

14. As to claim 6, Takagi discloses a method of exposing a bond pad comprising: forming the bond pad (105) (column 1, lines 32-34; Figure 1A); forming a dielectric layer (107) over the bond pad (105) (column 1, lines 32-34; Figure 1A); and exposing the bond pad (column 1, lines 45-47; Figure 1B). Although Takagi does not expressly disclose forming a resist mask with at least one opening to expose the dielectric layer (107) over the bond pad (105), this step is inherently present because the dielectric layer (107) is patterned by photolithography (column 1, lines 35-37). *See* Wolf I, pages 407-408.

15. Takagi does not expressly disclose the remaining elements as claimed by the Applicants. However, Takagi teaches forming at least one opening in the dielectric layer, having a sloped sidewall profile (column 2, lines 45-50) in order to avoid the generation of voids in the metal when the opening is filled, thus minimizing resistance (column 3, lines 5-10; Figure 1D). Moreover, Wolf II teaches a general approach to achieving a sloped sidewall, including heating the resist mask with the at least one opening to form a first sloped sidewall profile of the at least one opening ("the resist images are subjected to a postdevelop bake...resist flows during the bake, relaxing the vertical resist profile," page 105; Figure 13-4A, page 106); and etching the resist mask and exposed dielectric layer to form at least one opening in the dielectric layer ("[e]tching the resist and oxide at approximately the same rate replicates the tapered-resist profile into the contact sidewall," page 105). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the resist mask with the at least one opening to form a first sloped sidewall profile of the at least one opening; and etching the resist mask and exposed dielectric layer to form at least one opening in the dielectric layer. One who is skilled in the art would be motivated to minimize the generation of voids in the metal when the opening is filled, by forming a sloped sidewall and using a common method, such as heating the resist and etching, known to achieve the sloped profile.

16. Takagi does not expressly disclose a sidewall profile sloped from the bond pad surface to the upper end of the opening at an angle approximately 40 degrees to approximately 50 degrees relative to the bond pad surface. However, Wolf II teaches

that the slope of the sidewall is determined by the quality of the step coverage of the overlying metal ("it is important to give the contact hole a shape that will result in good step coverage by the metal that is deposited into it...better step coverage will be obtained if the walls of the contact opening are sloped and the top corners are rounded...," page 104) and that the slope of the photoresist can be controlled by baking ("[t]oo little baking results in vertical profiles, while excessive baking can result in closed contacts," page 105). Moreover, by suggesting that the quality of the metal coverage is controlled resist mask sidewall profile, Wolf II teaches that varying mask sidewall profile appears to reflect a result-effective variable which can be optimized. *See* MPEP § 2144.05 II. Mask sidewall profile can be varied accordingly, depending on the desired quality of the overlying metal coverage. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to select a sidewall profile sloped from the bond pad surface to the upper end of the opening at an angle approximately 40 degrees to approximately 50 degrees relative to the silicon surface. One who is skilled in the art would be motivated to optimize through routine experimentation sidewall profile. *See* MPEP § 2144.05 II. Although Wolf II teaches forming the inclined dielectric to the silicon surface (Figure 3-14A, page 106), it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the inclined dielectric to the bond pad surface (105) of Takagi. One who is skilled in the art would be motivated to from an electrical connection with an underlying conductive material (105).

17. As to claim 7, Takagi does not expressly disclose that the heating of the resist mask with the at least one opening persists for a time period ranging from approximately 15 seconds to approximately 90 seconds. However, Wolf II teaches that the slope of the photoresist can be controlled by baking time ("[t]oo little baking results in vertical profiles, while excessive baking can result in closed contacts," page 105). Moreover, Wolf II teaches, by disclosing that the time of exposure may be varied, that changing the time appears to reflect a result-effective variable which can be optimized. *See* MPEP § 2144.05 II. Time of exposure can be varied accordingly, depending on the desired outcome of the sidewall resist mask profile. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the resist mask with the at least one opening persists for a time period ranging from approximately 15 seconds to approximately 90 seconds. One who is skilled in the art would be motivated to optimize through routine experimentation of exposure times. *See* MPEP § 2144.05 II.

18. As to claim 8, Takagi does not expressly disclose that the heating of the resist mask with the at least one opening is performed at a temperature ranging from approximately 160 degrees Centigrade to approximately 190 degrees Centigrade. However, Wolf II teaches heating the resist mask to a temperature of about 150 degrees Centigrade, causing the resist to flow (page 105). Wolf II's temperature of 150 degrees Centigrade is close enough to Applicants' temperature range, such that similar results would be expected (e.g., the resist would flow). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the

resist mask with the at least one opening at a temperature ranging from approximately 160 degrees Centigrade to approximately 190 degrees Centigrade. One who is skilled in the art would be motivated to use a temperature range similar to 150 degrees Centigrade, which is known to result in resist flow.

19. As to claim 9, Wolf II discloses that the sloped sidewall profile of the at least one opening of the resist mask is wider at its upper end relative to its lower end (page 106, Figure 3-14A).

20. As to claim 10, Takagi does not expressly disclose forming a sloped sidewall profile having an angle of approximately 30 degrees to approximately 60 degrees relative to the surface of the bond pad. However, Wolf II teaches that the slope of the sidewall is determined by the quality of the step coverage of the overlying metal ("it is important to give the contact hole a shape that will result in good step coverage by the metal that is deposited into it...better step coverage will be obtained if the walls of the contact opening are sloped and the top corners are rounded...," page 104) and that the slope of the photoresist can be controlled by baking ("[t]oo little baking results in vertical profiles, while excessive baking can result in closed contacts," page 105). Moreover, by suggesting that the quality of the metal coverage is controlled resist mask sidewall profile, Wolf II teaches that varying mask sidewall profile appears to reflect a result-effective variable which can be optimized. *See* MPEP § 2144.05 II. Mask sidewall profile can be varied accordingly, depending on the desired quality of the overlying metal coverage. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a sloped sidewall profile having an angle of

approximately 30 degrees to approximately 60 degrees relative to the surface of the silicon. One who is skilled in the art would be motivated to optimize through routine experimentation sidewall profile. *See* MPEP § 2144.05 II. Although Wolf II teaches forming the inclined dielectric to the silicon surface (Figure 3-14A, page 106), it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the inclined dielectric to the bond pad surface (105) of Takagi. One who is skilled in the art would be motivated to from an electrical connection with an underlying conductive material (105).

21. As to claim 11, Takagi discloses at least one opening (108) to expose the dielectric layer (107) over the bond pad (105) exposes only a portion of the bond pad (105) surface (Figure 1B). Although Takagi does not expressly disclose forming a resist mask with at least one opening to expose the dielectric layer (107) over the bond pad (105), this step is inherently present because the dielectric layer (107) is patterned by photolithography (column 1, lines 35-37). *See* Wolf I, pages 407-408.

22. As to claim 12, Takagi does not expressly disclose that the forming of a resist mask with at least one opening to expose the dielectric layer over the bond pad exposes the entirety of the bond pad surface. However, Takagi discloses that the opening (108) is filled with a conductive material (110) (column 1, lines 52-55; Figures 1C-1D). Thus, exposing the entirely of the bond pad surface increases the surface area, which inherently increases the electrical conductivity of the damascene structure. *See* Callister, *Materials Science and Engineering*, 4th ed., John Wiley & Sons (1997), pages 592-93. Therefore, it would have been obvious to one of ordinary skill in the art

at the time the invention was made to form a resist mask with at least one opening to expose the dielectric layer over the bond pad exposes the entirety of the bond pad surface. One who is skilled in the art would be motivated to lower the overall resistance of the device.

23. As to claim 13, Wolf II discloses that the sloped sidewall profile of the opening in the dielectric layer ("SiO_2") is wider at its upper end relative to its lower end (page 106, Figure 3-14A).

24. As to claim 15, Wolf II discloses that the sloped sidewall profile of the opening in the dielectric layer has a slope sufficient to facilitate step coverage of a subsequent metallization ("it is important to give the contact hole a shape that will result in good step coverage by the metal that is deposited into it...better step coverage will be obtained if the walls of the contact opening are sloped and the top corners are rounded...," page 104).

Response to Arguments

25. Applicant's arguments (Applicants' Remarks, page 6), filed Dec. 5, 2005, with respect to the rejection of claim 1 under 35 U.S.C. 103(a) as unpatentable over Takagi, in view of Yu, in further view of Choi, have been fully considered and are persuasive. Applicants have pointed out that the Takagi reference does not teach or suggest forming a photoresist sidewall profile angle of "approximately 30 degrees to approximately 60 degrees" (page 6). Therefore, the rejection has been withdrawn.

However, upon further consideration, a new ground(s) of rejection is made in view of Wolf II.

26. Applicant's arguments (Applicants' Remarks, page 7), filed Dec. 5, 2005, with respect to the rejection of claim 1 under 35 U.S.C. 103(a) as unpatentable over Takagi, in view of Yu, in further view of Choi, have been fully considered and are persuasive. Applicants have pointed out that the Takagi reference does not teach or suggest forming a sidewall dielectric "from the bond pad surface to the upper end of the opening at an angle approximately 40 degrees to approximately 50 degrees" (page 7). Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Wolf II.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eric B. Chen whose telephone number is (571) 272-2947. The examiner can normally be reached on Monday through Friday, 8AM to 4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G. Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

EBC EBC
Jan. 12, 2005

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EXAMINER